Adhesive Capsulitis: Pathophysiology and Intervention

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Review of the Glenohumeral Capsule Structure

Adhesive capsulitis is a condition that is characterized by pain, limited range of motion, and limited functional use of the glenohumeral joint. The glenohumeral joint capsule surrounds the glenohumeral joint and is reinforced by the inferior, middle, and superior glenohumeral ligaments.[1] The coracohumeral ligament also helps provide support to the joint. These structures present as thickened regions of the glenohumeral joint capsule, and work with the muscles of the rotator cuff to provide stability to the joint.[1] With the humerus resting beside the trunk, the anterior and inferior regions of the capsule are relaxed and the superior portion is taut. As the joint is moved into the close-packed position, by externally rotating and abducting the humerus, the joint capsule will tighten, providing additional support.[1] In the loose-packed position there is enough laxity in the capsule and surrounding structures to distract the humeral head more than 2.5 cm from the glenoid fossa.[1] This laxity allows for the wide range of mobility seen at the glenohumeral joint. The glenohumeral ligaments can vary in size and attachment sites depending on the individual, for example, the middle glenohumeral ligament is absent in approximately 30% of individuals.[2] The superior glenohumeral ligament extends from the superior portion of the labrum to the upper neck of the humerus and on to the coracohumeral ligament.[1] The coracohumeral ligament, along with the superior glenohumeral ligament and the superior portion of the capsule make up what has been termed the rotator interval capsule, which bridges the gap of space found between the subscapularis and supraspinatus tendons.[1] The middle glenohumeral ligament connects the anterior proximal humerus to the anterior, superior portion of the labrum.[1] The inferior glenohumeral ligament is also referred to as the inferior glenohumeral ligament

complex, because it is made up of three components, the central axillary pouch, and the anterior and posterior ligament bands on either side of the axillary pouch.[1] The coracohumeral ligament is formed by two branches that begin at the base of the coracoid process and then insert on either the greater tubercle along with part of the supraspinatus, or the lesser tubercle along with the subscapularis.[1] Each of these ligaments add a unique contribution to the overall stability of the joint.

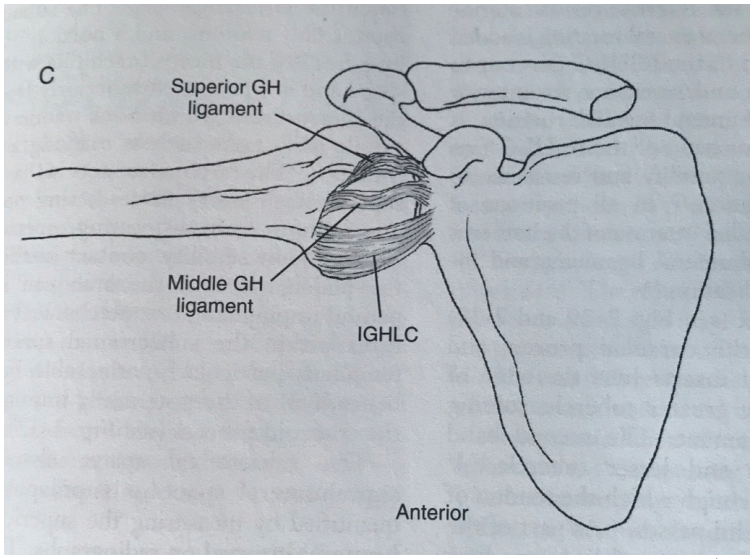


Image of glenohumeral ligaments from Ludwig et al.[1]

Epidemiology, Etiology, and Pathophysiology of Adhesive Capsulitis

According to the American Academy of Orthopedic Surgeons, adhesive capsulitis (AC), also known as frozen shoulder, is defined as "a condition of varying severity characterized by the gradual development of global limitation of active and passive shoulder motion where radiographic findings other than osteopenia are absent."[2] Also referred to as pariarthritis or painful stiff shoulder, adhesive capsulitis is thought to effect 2-5% of the general population.[2] AC is not commonly seen in individuals less than 40 years of age, but does typically effect people in their 50s and 60s with the highest instance rate occurring in the mid-50s.[2] AC occurs most often in only one shoulder, although the other shoulder has been found to become involved

within five years in 6-17% of individuals with adhesive capsulitis.[2] Most often the non-dominant shoulder is affected, and women are more likely to suffer from this condition than men.[2] This condition is more common in sedentary individuals rather than those with an active occupation like manual labor.[3] Little evidence is available pertaining to the prognosis of this condition, but in some individuals it has been known to last two to three years. Fifteen percent of people with adhesive capsulitis demonstrate some form of long-term limitation, with 40% reporting primarily mild, but persistent symptoms after the three-year point.[2] Individuals with adhesive capsulitis and type 1 diabetes appear to suffer from a more sustained course of this condition relative to those without diabetes.[2] This condition appears to occur more often in individuals with diabetes mellitus, with a lifetime prevalence of 76 percent.[2] It has also been associated with autoimmune disease, dyslipidemia, prolonged immobilization, stroke, thyroid disease, and in limited instances with protease inhibitors used to treat HIV infection, and also with Parkinson's disease.[2]

Adhesive capsulitis can be either primary, or secondary occurring after other injuries to the shoulder. Common injuries preceding the development of this condition include rotator cuff tears, shoulder surgery, and fractures of the proximal humerus.[2] AC has also been found to occur after cardiac and neurosurgeries.[2] There is a limited understanding of the pathophysiology behind adhesive capsulitis including an ongoing debate over whether inflammation or the development of fibrosis is the primary pathology underlying this condition.[2] Based on evidence seen during arthroscopic procedures, some think that initially inflammation develops in the joint capsule, specifically surrounding the axillary fold, the rotator cuff interval, the coracohumeral ligament, and the anterosuperior portion of the joint capsule.[2] The inflammation is then followed by the formation of adhesions in the synovial lining of the joint, resulting in reduced joint volume due to the contraction and thickening of the collagenous structures around the joint and

the joint capsule.[2] According to Neviaser et al., normal capacity of the glenohumeral joint by volume is 28 to 35 mL, however, in a joint with adhesive capsulitis only 5 to 10 mL of fluid can be injected.[3]

Clinical Presentation of Adhesive Capsulitis

Patients with adhesive capsulitis will often present with persistent, severe shoulder pain at night, and an inability to perform their normal job requirements, activities of daily living, or hobbies as a result of progressive shoulder stiffness and pain.[2] They are often unable to sleep on the involved shoulder and may begin to have difficulty with activities such as combing their hair or dressing.[3] A gradual onset of pain is more common with adhesive capsulitis than most other shoulder pathologies, and may include radicular pain at the deltoid origin.[3] Pain commonly will increase at the patient's end range of motion and for loss of movement and stiffness to increase as the condition progresses.[2] Adhesive capsulitis has been categorized into both three and four stages of progression, but for the purpose of this paper, the three stage progression of the freezing (stage one), frozen (stage second), and thawing (stage three) will be used.[2,3] The first stage, thought to last two to nine months, is typified by worsening stiffness, but primarily diffuse and intense shoulder pain that appears worse at night.[2] Strength of the rotator cuff muscles is usually preserved however loss of external rotation may be an early symptom.[3,5] Patients are typically unable to pinpoint a specific location of pain or tenderness, however, because the long head of the biceps tendon shares synovium with the glenohumeral joint, some individuals may experience tenderness at this location.[3] Angiogenesis and synovitis can be seen when the shoulder is examined arthroscopically in this stage.[5] Stage two, which can last from four to twelve months, involves a substantial reduction in normal shoulder range of motion for multiple movements, especially external rotation, and increased stiffness, but usually decreased pain.[2]

Angiogeneisis and synovitis, to a lesser degree, can still be seen in the joint, and fibrosis of the capsuloligamentous structures results in destruction of the axillary fold and loss of normal shoulder motion even when examined under anesthesia.[5] Patients may be unable to reach overhead or put on a belt. The final stage, which can occur over 5 to 24 months, typically includes a slow return of function and improved range of motion.[2] The duration of these stages does not appear to be dependent on the cause of the condition or vary based on comorbidities.[2]

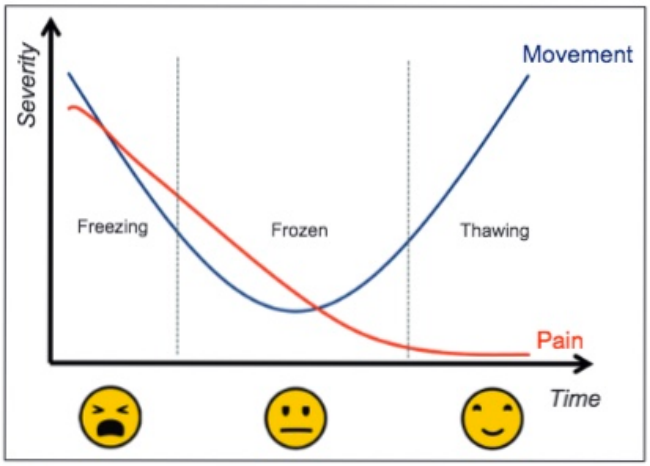


Fig. 1 Chart shows the clinical presentation of frozen shoulder. Icons with facial expressions represent the level of pain of the patient.

Figure of adhesive capsulitis symptoms and stages from Chan et al.[6]

Differential Diagnosis

In diagnosing adhesive capsulitis, it is important to rule out conditions related to subacromial pathologies such as impingement syndrome, rotator cuff tendinopathy, and inflammation of the subacromial bursa, as these can mimic the symptoms also seen with early adhesive capsulitis such as reduced active shoulder range of motion and increased pain.[2] In adhesive capsulitis the increased pain and motion restriction will be caused by a mechanical limitation that results in both active and passive range of motion loss, whereas with subacromial pathologies the passive range of motion should remain.[2] While adhesive capsulitis may develop

following subacromial pathologies or other shoulder conditions or injuries, patients may also describe an insidious onset with worsening pain and reduced range of motion as noted above. Patient age may also be helpful in ruling in or out a diagnosis of adhesive capsulitis as the condition in uncommon in individuals younger than 40. Additionally, diagnosis of shoulder osteoarthritis or rotator cuff tear should be more seriously considered if the patient is older than 70, as these conditions become more common at that point.[2] Radiographs are commonly used as part of a medical assessment in order to rule out other conditions such as an undiagnosed dislocated shoulder, calcific tendinitis, and arthritis.[3] The following conditions should also be included in the differential diagnosis for adhesive capsulitis, although they are less common than those noted above: myocardial ischemia, apical lung cancer or other malignancy and possible metastases, degenerative disk disease affecting the cervical spine, pain referred from either the diaphragm or the cervical spine, and polymyalgia rheumatica.[2] The APTA's clinical practice guideline includes the following conditions in the differential diagnosis list for adhesive capsulitis:

Differential Diagnosis list:[5]		
Acute calcific tendonitis/bursitis	Arthrosis of the shoulder, primary	Arthrosis of the shoulder, secondary
Bursitis of the shoulder	Cervicalgia	Cervical disc disorders
Cervicobrachial syndrome	Contusion of the shoulder and upper arm	Diseases of the digestive system
Fibromyalgia	Fracture of the clavicle	Fracture of the scapula
Fracture of the shaft of the humerus	Fracture of the upper end of the humerus	Impingement syndrome of the shoulder
Injury of blood vessels at the shoulder, and upper-arm level, included avascular necrosis	Injury of the muscle and tendon at shoulder and upper-arm level including labral lesions	Injury of nerves at shoulder and upper-arm level, including suprascapular nerve entrapment
Juvenile rheumatoid arthritis	Neoplasm	Osteoarthritis of the acromioclavicular joint
Osteoarthritis of the cervical spine	Osteoarthritis of the glenohumeral joint	Osteoporosis with a pathological fracture
Pain in the thoracic spine	Persistent somatoform pain	Psychological and behavioral

	disorder	factors associate with disorders or diseases
Pyogenic arthritis	Radiculopathy	Rheumatoid arthritis
Somatoform autonomic dysfunction	Sprain and strain of the acromioclavicular joint	Sprain and Strain of the sternoclavicular joint

Medical Management of Adhesive Capsulitis

Some physicians do not recommend substantial treatment for adhesive capsulitis, considering it to be a self-limiting condition that resolves on its own with time.[3] Therapeutic interventions are typically targeted at increasing range of motion and reducing pain, however there is some contradiction within the evidence regarding the level of improvement gained when documented by objective outcome measures.[3] Independent of the stage of this condition, physical therapy is one of the primary interventions used to address the symptoms of adhesive capsulitis, with a focus on progressive gentle stretching, however the treating physician may also recommend nonsteroidal anti-inflammatories, or oral steroids to make activities of daily living, therapy, and sleeping less painful.[3,5] Intra-articular steroid injections have not proven to offer any long-term benefit when compared to individuals that did not received injections, but may be used for short-term relief and with individuals with more severe symptoms.[3,5] If physical therapy and other conservative interventions are not successful, the patient may choose to pursue a surgical intervention. Neviaser et al. note that individuals that are younger when their symptoms begin, have a more severe presentation, and have a sustained reduction in their range of motion despite complying with physical therapy for longer than 4 to 6 months are more likely to require surgical intervention.[3] Manipulation under anesthesia was previously the primary surgical method used to improve range of motion and function in individuals with adhesive capsulitis.[3] This involved the administration of either a regional or general anesthetic, followed by the physician's external

rotation of the humerus to avoid hitting the acromion with the greater tuberosity, and elevation of the arm over the patient's head while stabilizing the scapula.[3] The arm is then returned to 90° of elevation and fully internally rotated. The accompanying popping sound that this movement elicits is indicative of the intentional capsule rupture.[3] However, an arthroscopic procedure has replaced this intervention in many surgical facilities because of its ability to allow for confirmation of the diagnosis, full inspection of the joint, more control and precision with the capsulotomy, and improved outcomes with return of function and pain reduction sustained over two to five years and longer with continued follow up.[3] Compliance with physical therapy and positioning recommendations after surgery are critical to preventing recurrent stiffness and loss of motion after surgery. One physician recommended that the patient be immobilized in external rotation and 90° abduction with the head of the hospital bed at 30° of elevation.[3]

Photograph demonstrating the immediate postoperative position for the first night following management of adhesive capsulitis and while sleeping throughout the hospital stay.

Figure of postoperative day zero positioning from Neviaser et al.[3]

According to this protocol, on postoperative day one patients are asked to begin exercises including internal and external rotation, and reaching over the top of their head to touch their contralateral ear. They are instructed to keep their arm in 90° or greater of abduction and to keep

the hand of their operative arm on the top of their head while eating, using the bathroom, and performing other ADLs.[3] They will begin outpatient physical therapy after discharge, which should avoid vigorous and extremely painful movements, but should help retain range of motion and include a home stretching program to be performed three times per day.[3]

Arthrographic distension or hydrodilatation is another medical intervention that is sometimes used to treat adhesive capsulitis. The procedure involves the injection of either saline or steroids into the glenohumeral joint for the purpose of disrupting the adhesions that restrict the range of motion and functional use of the arm.[7] A Cochrane review of the literature pertaining to this procedure found that it was able to provide improvement in pain, function, and range of motion on a short-term basis for individuals with adhesive capsulitis.[7] Pain outcome measures were improved over the placebo at 3 weeks, and disability outcomes were reduced at 3-, 6-, and 12-weeks.[7] However, they were unable to conclude that this procedure was superior to the other options that are also available with no difference in disability or pain when compared to normal steroid injections.[7]

Physical Therapy Evaluation and Examination for Adhesive Capsulitis

Physical therapy evaluation for suspected adhesive capsulitis will involve many of the same tools and techniques used to asses nearly any other shoulder pathology. Patient history and report of symptoms are important for determining a correct diagnosis. Pain level should be assessed, typically using a numeric rating or visual analog scale, at the outset and also after range of motion testing to assess irritability.[4] Patient posture should be assessed in both sitting and standing to identify any abnormalities, and vital signs should be taken and documented. To rule out cervical spine pathology, an upper quarter screen should be performed, including cervical

range of motion and special tests, deep tendon reflexes, dermatome and myotome testing, upper extremity neural tension testing, and upper extremity joint screening.[4] Range of motion measurements for the glenohumeral joint should be taken and documented for both active and passive movements with a goniometer. These measurements should include external rotation, internal rotation, shoulder abduction, and shoulder flexion.[5] Accessory movement of the joint should be assessed for all planes of motion, and end feel should also be assessed and documented. Strength testing of the shoulder muscles should be performed either through manual muscle testing or with a dynamometer for internal and external rotation and shoulder elevation.[4] Kinesthetic and proprioceptive testing should also be performed and the results documented.[4] There are also many functional outcome measures that are commonly used for shoulder assessment including the Disabilities of the Arm, Shoulder and Hand (DASH), the QuickDASH, the Shoulder Pain and Disability Index (SPADI), the American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form (ASES), the University of Pennsylvania Shoulder Score, and the Patient-Specific Functional Scale (PSFS). The DASH, SPADI, and the ASES specifically are recommended because they are well researched and have validated psychometric properties including Minimal Detectable Change and Minimal Clinically Important Difference values to help document clinically significant improvements for patients.[4,5]

Psychometric Properties of Tools Used to Measure Pain and Disability[4]

Outcome Measures	Minimal Detectable Change (MDC) (Points)	Minimal Clinically Important Difference (MCID) (Points)
American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form (ASES)	9.4	6.4
Disabilities of the Arm, Shoulder and Hand (DASH)	6.6-12.2	10.2
Shoulder Pain and Disability Index (SPADI)	18	8.0-13.1

The University of Pennsylvania Shoulder Score	12.1	Not available
Patient-Specific Functional Scale (PSFS) (total score)	0.97	1.29
QuickDASH	11.2	8

Short-term goals for physical therapy often include reduction in pain level, improved range of motion, and increased functional use of the arm.[5] Goals of this nature are more realistic and achievable as certain patients may not regain their full range of motion for multiple years, if ever, and some healthcare providers recommend advising the patient of this in order to allow them to come to terms with the possibly of a sustained functional limitation.[3,6] Over time, as the fibrotic and thickened capsular tissue remodels into more normal collagenous tissue, the patient should experience increasingly improved function.[5] Please see Appendix 1 for the APTA's recommendations for evaluation and interventions of adhesive capsulitis.

Interventions for Adhesive Capsulitis

Steroid injections are sometimes used to help improve pain relief and reduce the body's inflammatory response. Multiple studies have examined the use of this intervention in individuals with adhesive capsulitis and have found that while there are short-term benefits for using steroid injections along with physical therapy as a combined treatment, these improvements are not sustained over time.[5] For example, a study that included four intervention groups including intra-articular corticosteroid injections, combined injections and physical therapy, combined physical therapy and saline injections, and just saline injections found improved SPADI scores for both of the corticosteroid groups, but not for the non-injection groups at 6 weeks, with the injection and physical therapy group showing the greatest improvements.[5] At 6 months active and passive range of motion was improved in the injection

and physical therapy group as compared to the others, but SPADI scores were similar across all four groups; however, at the 12-month follow up there were no differences between the four groups.[5] Patient education is also considered a particularly important intervention when treating patients with this condition. They may be alarmed and concerned by the insidious, and seemingly progressive nature of the condition, but providing education regarding the pathological processes and what to expect regarding the normal course of the condition may give them relief and help them understand what to expect as they progress and begin to recover function.[5] It is also important to emphasize the need for ongoing functional use of the involved arm, specifically within their pain-free range of motion, and stretching exercises that are in line with their level of irritability and the stage of their recovery.[3]

Joint mobilizations have also been shown to be beneficial for pain relief, improved range of motion, and function for individuals with adhesive capsulitis; however, the current evidence does not support the superiority of this intervention over others.[5] Modalities may also be used to reduce pain and allow for increased range of motion, but modalities alone do not appear to impact the normal course of the condition.[5] Electrical stimulation, shortwave diathermy, and ultrasound have been shown to help reduce pain and improve range of motion when combined with stretching and mobility exercises.[5] A Cochrane review of electrotherapy modalities used to help treat individuals with adhesive capsulitis also found some evidence that low-level laser therapy (LLLT) may help improve pain and function.[8] One trial of low quality evidence found that six days of treatment with LLLT provided improved "global treatment success" when compared to a placebo.[8] Another trial of moderate quality evidence determined that eight weeks of treatment with combined exercise and LLLT was better able to reduce pain at the fourth week of treatment, and showed improved function for four months when compared to only exercise.[8]

A less commonly used intervention called translational manipulation may also be an option for individuals with adhesive capsulitis. This treatment has been used for individuals whose adhesive capsulitis was termed unresponsive and did not improve with conservative management.[5] It involves the administration of an interscalene brachial plexus nerve block by an anesthesiologist prior to the procedure, then two people perform the manipulation.[5] One individual stabilizes the scapula while the other glides the proximal humerus inferiorly, then posteriorly.[5] The inferior translation is thought to break up adhesions of the inferior fold which cause limitations in humeral elevation, while the posterior translation is suspected to stretch the rotator cuff interval and the posterior capsule, and improve internal and external rotation range of motion.[5] One study tested this procedure on eight participants who also received additional physical therapy, modalities, home exercises, and an oral steroid prescription following the procedure.[5] Two of the eight did not experience an improvement, but six of the eight reported sustained improvements in active and passive range of motion and functional use of their shoulder.[5]

The evidence for stretching exercises shows that they can improve glenohumeral range of motion and reduce pain, however there is no consistent evidence available that indicates they are superior to the other treatments discussed, especially early on in the course of the condition.[5] Many studies found that at the three to six month follow up, stretching exercises produced small or no changes in outcome measures.[5] There is a dearth of high quality evidence on this topic, as most studies fail to describe their protocols, leaving no indication of what the ideal frequency and dosage of these exercises should be.[5] There does appear to be a consensus however, that inferior outcomes may result from stretching into the painful range.[5]

Acupuncture has also been used in some cases to treat adhesive capsulitis and other causes of shoulder pain, as it is thought to produce an analgesic effect which helps reduce symptoms of pain.[8] A Cochrane review was performed on the literature available examining the effectiveness of this intervention. They found that the evidence neither supports or rejects the use of this intervention for the treatment of shoulder pain.[8] In general, they noted that the quality of evidence was very poor with minimal details given regarding how the interventions were executed. There was limited evidence that acupuncture may provide some short-term pain relief and functional improvement; however, the authors questioned the clinical significance of the amount of change reported, given the outcome measure that was used.[8]

Physical therapy interventions should be determined based on the irritability of the patient's condition.[5] For a patient in the high irritability stage, interventions should include stretching within the pain-free range of motion. This may be either active-assistive or passive stretching and should be held for short durations, such as one to five seconds.[4] Pain relief should be encouraged through the use of cryotherapy, electrical stimulation, and heat.[4] Manual therapy may also be used to help with pain, range of motion, and functional use of the arm.[4] Patient education, as noted above, should also be included pertaining to the intensity of exercises and stretching, and recommended modifications to activities of daily living.[4] Steroid injections may also be helpful at this juncture to provide some short-term pain relief.[4] Once the patient has entered the moderate-irritability stage, active stretching may also be included and sustained for longer timeframes of 5-15 seconds, but still within the pain-free range.[4] Manual therapy and modalities for pain relief should be continued. Functional activity training can be incorporated to allow for more use of the arm without increasing pain.[4] Once in the low irritability stage cyclic

loading of the joint is allowed along with more intense stretching to the end range, with increased duration and overpressure to help regain range of motion.[4]

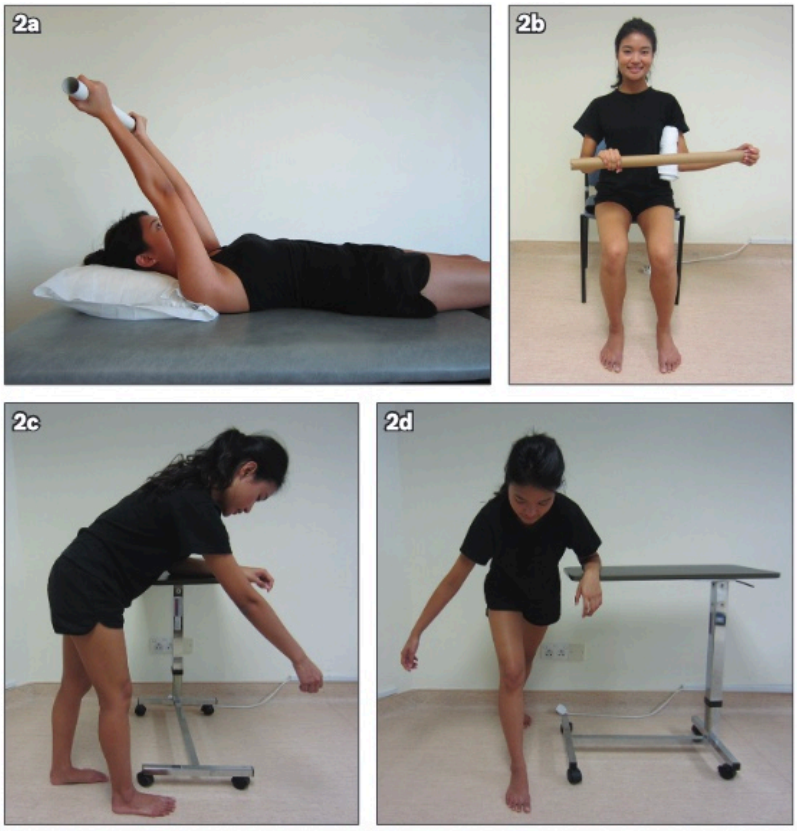
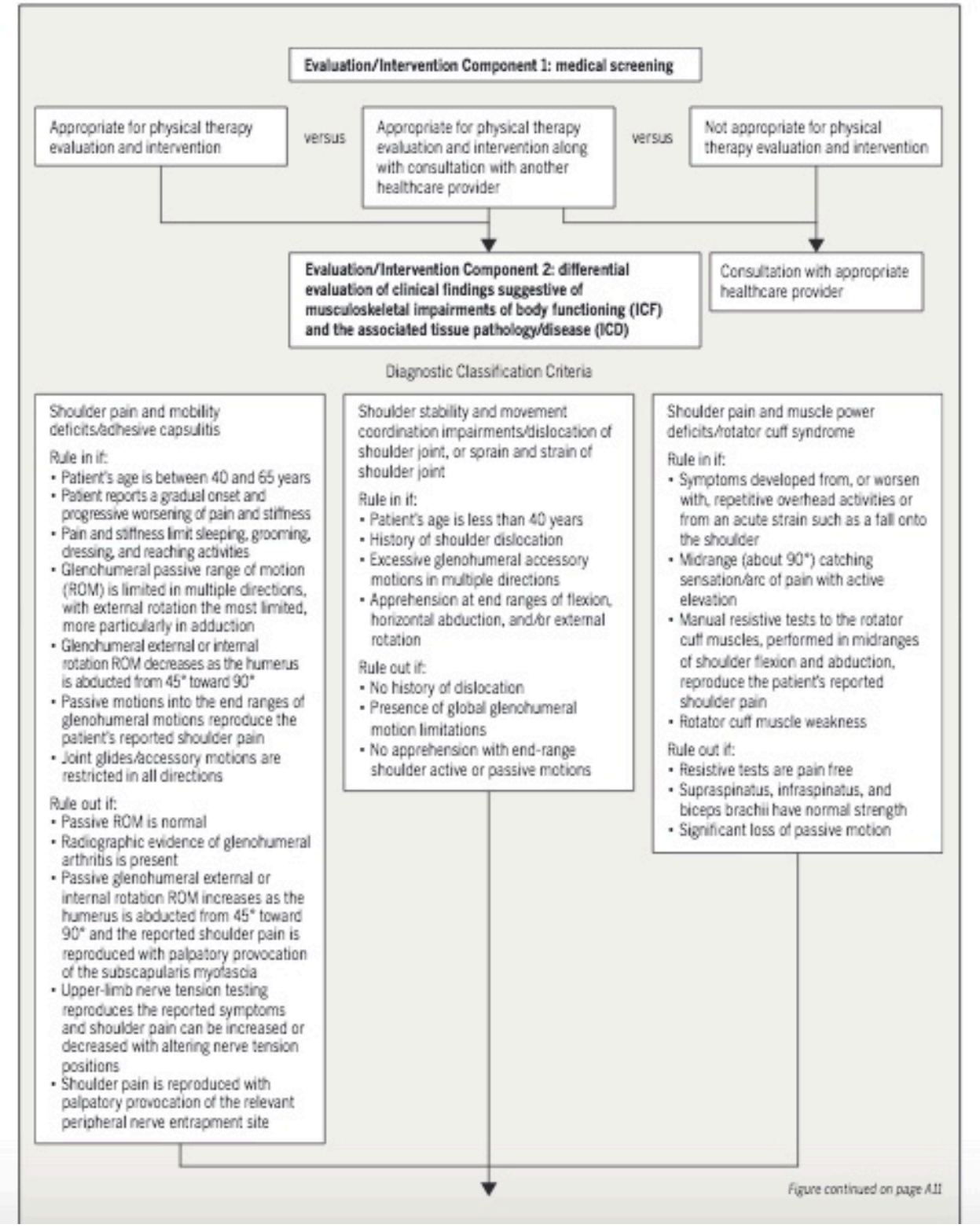
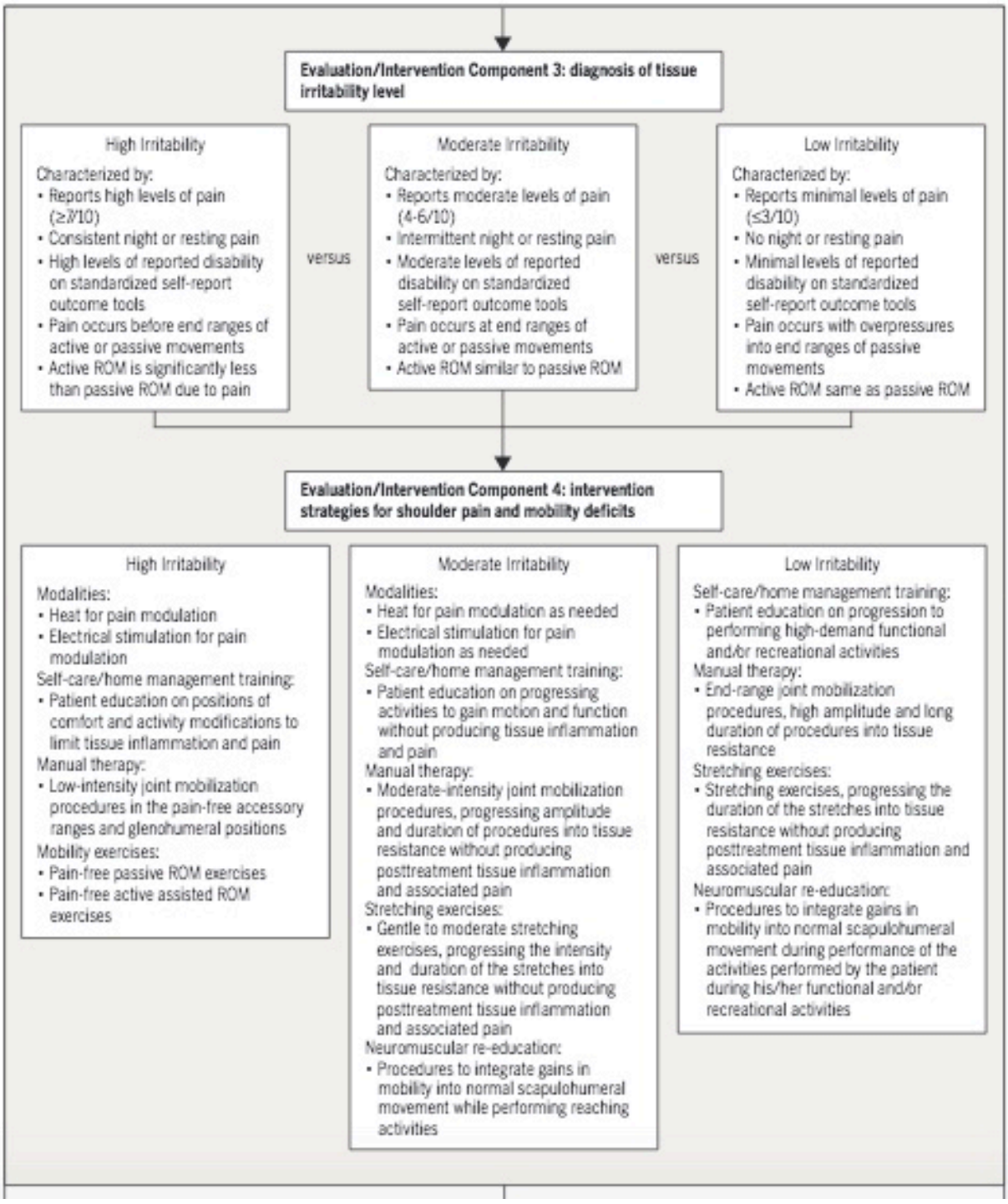


Fig. 2 Photographs show examples of stretching exercises: (a) active assisted shoulder forward flexion with wand; (b) active assisted shoulder external rotation with wand; and (c & d) pendulum exercise.

Image of shoulder stretches and exercises from Chan et al.[6]

Appendix 1: APTA clinical practice guideline for evaluation and interventions for adhesive capsulitis.[5]




Evaluation/Intervention Component 3: diagnosis of tissue irritability level
High Irritability
Characterized by:
• Reports high levels of pain (≥7/10)
• Consistent night or resting pain
• High levels of reported disability on standardized self-report outcome tools
• Pain occurs before end ranges of active or passive movements
• Active ROM is significantly less than passive ROM due to pain
versus
Moderate Irritability
Characterized by:
• Reports moderate levels of pain (4-6/10)
• Intermittent night or resting pain
• Moderate levels of reported disability on standardized self-report outcome tools
• Pain occurs at end ranges of active or passive movements
• Active ROM similar to passive ROM
versus
Low Irritability
Characterized by:
• Reports minimal levels of pain (≤3/10)
• No night or resting pain
• Minimal levels of reported disability on standardized self-report outcome tools
• Pain occurs with overpressures into end ranges of passive movements
• Active ROM same as passive ROM
Evaluation/Intervention Component 4: intervention strategies for shoulder pain and mobility deficits
High Irritability
Modalities:
• Heat for pain modulation
• Electrical stimulation for pain modulation
Self-care/home management training:
• Patient education on positions of comfort and activity modifications to limit tissue inflammation and pain
Manual therapy:
• Low-intensity joint mobilization procedures in the pain-free accessory ranges and glenohumeral positions
Mobility exercises:
• Pain-free passive ROM exercises
• Pain-free active assisted ROM exercises
Moderate Irritability
Modalities:
• Heat for pain modulation as needed
• Electrical stimulation for pain modulation as needed
Self-care/home management training:
• Patient education on progressing activities to gain motion and function without producing tissue inflammation and pain
Manual therapy:
• Moderate-intensity joint mobilization procedures, progressing amplitude and duration of procedures into tissue resistance without producing posttreatment tissue inflammation and associated pain
Stretching exercises:
• Gentle to moderate stretching exercises, progressing the intensity and duration of the stretches into tissue resistance without producing posttreatment tissue inflammation and associated pain
Neuromuscular re-education:
• Procedures to integrate gains in mobility into normal scapulohumeral movement while performing reaching activities
Low Irritability
Self-care/home management training:
• Patient education on progression to performing high-demand functional and/or recreational activities
Manual therapy:
• End-range joint mobilization procedures, high amplitude and long duration of procedures into tissue resistance
Stretching exercises:
• Stretching exercises, progressing the duration of the stretches into tissue resistance without producing posttreatment tissue inflammation and associated pain
Neuromuscular re-education:
• Procedures to integrate gains in mobility into normal scapulohumeral movement during performance of the activities performed by the patient during his/her functional and/or recreational activities

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